ID	Data Element 35	Size 35	Data Element 36	Size 36	Data Element 37	Size 37	Data Element 38	Size 38
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69		0		0
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71		0		0
72		0		0

ID	Physical Flow	Architecture Flow	Message	Message Size
73	update the in-vehicle kiosk	schedules, fare info, and request processing	Update the in-vehicle kiosk	4915808
74	reservation and fare payment (credit card)	fare payment and status	Request Vehicle Fare Payment	648
75	reservation and fare payment (credit card)	schedules, fare info, and request processing	Transit_Vehicle_Fare_Payment_Debited	64
76	reservation and fare payment (SMART card)	fare payment and status	Request_Vehicle_Fare_Payment	648
77	reservation and fare payment (SMART card)	schedules, fare info, and request processing	Transit_Vehicle_Fare_Payment_Request	72
78	reservation and fare payment (SMART card)	fare payment and status	Transit_Vehicle_Fare_Payment_Confirmation	64
79	transit vehicle conditions		Transit Vehicle Conditions Request	72
80	transit vehicle conditions	vehicle measures and vehicle probe data	Vehicle measures and vehicle probe data	476

ID	Src	Dst	Data Element 1	Size 1	Data Element 2	Size 2	Data Element 3	Size 3	Data Element 4	Size 4
73	TRMS	TRVS	Selsyn	8	Flag	4	Transaction_Type	16	Message_Length	12
74	TRMS	TRVS	Selsyn	8	Flag	4	Transaction_Type	16	Message_Length	12
75	TRVS	TRMS	Selsyn	8	Flag	4	Transaction_Type	16	Message_Length	12
76	TRMS	TRVS	Selsyn	8	Flag	4	Transaction_Type	16	Message_Length	12
77	TRVS	TRMS	Selsyn	8	Flag	4	Transaction_Type	16	Message_Length	12
78	TRMS	TRVS	Selsyn	8	Flag	4	Transaction_Type	16	Message_Length	12
79	TRMS	TRVS	Selsyn	8	Flag	4	Transaction_Type	16	Message_Length	12
80	TRVS	TRMS	Selsyn	8	Flag	4	Transaction_Type	16	Message_Length	12

ID	Data Element 5	Size 5	Data Element 6	Size 6	Data Element 7	Size 7
73	transit_services_for_corrections	248	transit_services_for_eta	112	transit_services_for_vehicle_fares	4915288
74	request_vehicle_fare_payment	592	CRC	16		0
75	transit_vehicle_fare_payment_debited	8	CRC	16		0
76	request_vehicle_fare_payment	592	CRC	16		0
77	transit_vehicle_fare_payment_request	16	CRC	16		0
78	transit_vehicle_fare_payment_confirmation	8	CRC	16		0
79	Transit Conditions Request	16	CRC	16		0
80	transit_vehicle_eta	216	transit_vehicle_schedule_deviations	192	Agency_Specific_Data	12

ID	Data Element 8	Size 8	Data Element 9	Size 9	Data Element 10	Size 10	Data Element 11
73	transit_vehicle_fare_data	104	CRC	16		0	
74		0		0		0	
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76		0		0		0	
77		0		0		0	
78		0		0		0	
79		0		0		0	
80	CRC	16		0		0	

ID	Size 11	Data Element 12	Size 12	Data Element 13	Size 13	Data Element 14	Size 14
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76	0		0		0		0
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79	0		0		0		0
80	0		0		0		0

ID	Data Element 15	Size 15	Data Element 16	Size 16	Data Element 17	Size 17	Data Element 18	Size 18
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77		0		0		0		0
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79		0		0		0		0
80		0		0		0		0

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74		0		0		0		0
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78		0		0		0	
79		0		0		0	
80		0		0		0	

ID	Data Element 27	Size 27	Data Element 28	Size 28	Data Element 29	Size 29	Data Element 30	Size 30
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80		0		0		0		0

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78		0		0		0		0
79		0		0		0		0
80		0		0		0		0

ID	Data Element 35	Size 35	Data Element 36	Size 36	Data Element 37	Size 37	Data Element 38	Size 38
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80		0		0		0		0

ID	Data Element 39	Size 39	Data Element 40	Size 40
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74		0		0
75		0		0
76		0		0
77		0		0
78		0		0
79		0		0
80		0		0

NATIONAL ITS PROGRAM PLAN

EXECUTIVE SUMMARY

FIRST EDITION
MARCH 1995

Edited by:

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Joint Program Office for ITS
United States Department of Transportation

H. Douglas Robertson
Plans and Programs
ITS America

Abstract

The purpose of the *National ITS Program Plan* is to guide the development and deployment of Intelligent Transportation Systems (ITS) in the United States. This first edition of the Plan was a joint effort of ITS America and the United States Department of Transportation. The plan was developed through a consensus process involving the entire ITS community. The *National ITS Program Plan* consists two volumes. An Executive Summary and a Synopsis are also available. The Executive Summary provides a very brief overview of the goals, objectives, and recommendations presented in the *National ITS Program Plan*. The Synopsis provides a 50 page encapsulation of the major subject areas within the document, with special emphasis on deployment. Volume I focuses on goals, compatibility, deployment, and program assessment. Volume II contains detailed descriptions and plans for each of the 29 user services.

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PREFACE

This first edition of the *National ITS Program Plan* was a joint effort of ITS America and the United States Department of Transportation. The plan was developed through a consensus building process which sought the involvement of the entire ITS community. Over 36 individuals participated actively as authors, and well over 200 individuals from a wide range of organizations critiqued, commented, and otherwise contributed substantially to the material presented here.

The *National ITS Program Plan* consists of two volumes. An Executive Summary and a Synopsis are also available. The Executive Summary provides a very brief overview of the goals, objectives, and recommendations presented in the *National ITS Program Plan*. The Synopsis provides a 50 page encapsulation of the major subject areas within the document, with special emphasis on the area of deployment. Volume I focuses on the goals of ITS, compatibility, deployment, and program assessment. Volume II contains detailed descriptions and plans for each of the 29 user services.

Work on the *National ITS Program Plan* formally commenced in June,1993. The Second and Final Drafts of the Plan, completed in May 1994 and November 1994 respectively, incorporated the comments and contributions of a substantial number of individuals and organizations. In total, more than 4,000 draft copies of the plan were distributed to ITS America members, U.S. DOT staff, and the general public through the Federal Register. Over 200 individuals and organizations commented and provided input for one or more of the drafts.

The process of developing the *National ITS Program Plan* was, in itself, a valuable exercise. The focus of the first draft was upon the creation of the user service development plans now contained in Volume II. The remainder of the draft consisted largely of annotated outlines. A Joint Writing Team (JWT) was formed and given the responsibility of developing the Plan. In the second draft, the deployment and deployment considerations chapters took shape, and with the third draft, deployment scenarios emerged. Each draft represented significant advances in our deliberations on ITS technology, systems, deployments, and impacts.

Overall guidance to the JWT on the Plan was provided by U.S. DOT officials and the ITS America Planning Committee. The Joint Writing Team, co-chaired by Doug Robertson (ITS America) and Gary Euler (US DOT ITS Joint Program Office), consisted of ITS America and US DOT staff and ITS America members. The JWT members, acknowledged by name and organization below, worked extensively with ITS America members, U.S. DOT staff, and the general public with a goal of ensuring balanced representation of the goals, objectives, concerns, and needs of a diverse ITS Community.

The field of ITS is advancing rapidly on many fronts; keeping abreast of it will require a continuing effort. This document will serve as the basis for periodic updates, providing information on activities, as well as projections for the future.

I. INTRODUCTION

Surface transportation in the United States faces a number of challenges. Despite the fact that the United States has one of the best surface transportation systems in the world, mobility is declining and safety remains a serious problem. Inefficient movement of vehicles reduces productivity, wastes energy, increases emissions, and threatens the quality of life we enjoy. The continued development and maintenance of a safe, efficient, environmentally responsible transportation system is vital to the social and economic health of the nation.

Intelligent Transportation Systems (ITS) apply advanced and emerging technologies in information processing, communications, control, and electronics to meet surface transportation needs. ITS, formerly called Intelligent Vehicle-Highway Systems (IVHS), provide a means to address current problems, as well as anticipate and address future demand through an intermodal, strategic approach to transportation. While ITS technology alone cannot solve our transportation problems, it can enable us to re-think our approach to problem solutions, as well as to make current activities more efficient.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA)

The Intelligent Vehicle Highway Systems Act within the Intermodal Surface Transportation Efficiency Act (ISTEA) established the IVHS (now ITS) program in the United States and called for the development of the US DOT Strategic Plan for IVHS. The purpose was to provide a new vision of surface transportation in America.

The Act was structured to address a number of the societal challenges involved in providing accessible transportation, including the goals of:

- enhancing the capacity, efficiency, and safety of the highway system, including alternatives to additional physical capacity;
- enhancing efforts to attain air quality goals established by the Clean Air Act;
- reducing societal, economic, and environmental costs associated with traffic congestion;
- developing and promoting an ITS industry in the United States, particularly creating an American presence in this emerging field of technology; and
- developing a technology base for ITS systems.

Goals and Objectives

The national ITS program goals and objectives evolved as the program developed. The program goals set out in ISTEA provided the basic framework, and were expanded in both ITS America's *Strategic Plan for Intelligent Vehicle-Highway Systems* and the US DOT's *IVHS Strategic Plan*. The goals are to:

- Improve the safety of the nation's surface transportation system;
- Increase the operational efficiency and capacity of the surface transportation system;
- Reduce energy and environmental costs associated with traffic congestion;

- Enhance present and future productivity;
- Enhance the personal mobility and the convenience and comfort of the surface transportation system; and
- Create an environment in which the development and deployment of ITS can flourish.

Potentially, the most effective approaches to developing a more efficient, safe, environmentally conscious transportation system are those which address the fundamental goal of transportation as one of "moving passengers and goods" through a system by the most efficient, effective means possible. This requires that transportation policy makers, service providers, planners, and users develop a "systems approach" to transportation. The system is viewed as an integrated transportation network where users have the choice of a number of modes, routes, and travel times, and may move easily through the system. Achieving more integrated transportation systems requires institutional, legal, and technical innovation. In some instances, the technological capabilities provided by ITS can facilitate institutional changes which remove barriers to the development of integrated systems.

II. THE PLAN

The Strategic Plans for IVHS developed by ITS America and the US DOT articulated the need to develop a framework for the deployment of ITS. This framework would provide a common conceptual language for discussing ITS, address the potential roles of various levels of government, and identify and address the impacts of ITS and the potential barriers to the development of beneficial services. The specific goals of the National ITS Program Plan (NPP) are to:

- Promote shared ITS goals, providing integrated descriptions of activities that are public, private, and cooperative;

- Guide ITS investment decisions, laying a foundation for the private and public sectors, and service consumers;

- Encourage coordination by providing a framework for planning;

- Focus on deployment by reflecting on the key forces affecting deployment decisions, and the order in which user services can and likely will be deployed;

- Facilitate the development of an intermodal, integrated national transportation system by presenting visions of ITS deployment which facilitate intermodal linkages for passengers and freight.

The NPP is the result of a joint effort of the US DOT and ITS America. Authors and editors were drawn from ITS America members and staff, and US DOT staff. In total, more than 35 individuals contributed substantial text and editorial assistance in the formation of this plan. Another 200 reviewed one or more drafts of the document. The contributors to the plan included representatives from local, state, and federal government; universities and research organizations; other societies and public interest groups; and the private sector. Private sector

participants represented manufacturers, transportation service providers, communications companies, and transportation consultants. In short, this diverse group represented most of the ITS community.

The NPP is structured around the concept of "User Services." These User Services are, in essence, products and services that may be developed to meet the needs of users. In this context, the term "user" refers to a wide range of individuals and organizations including travelers, service providers, and transportation policy makers.

The 29 user services are shown in Table 1. Some of these are oriented toward meeting the needs of individual travelers, others focus on efforts to provide efficient, cost effective transportation services under a wide range of circumstances. These services do not cover every possible application of ITS, rather they are intended as steps toward the development of a common framework for discussion. The list of services and their definitions are expected to evolve over time. New services may be added and existing service descriptions may change.

III. THE DEPLOYMENT OF ITS

The deployment of ITS will be distinctly different from the centralized, staged development of major national systems in the aviation, defense, and space programs. One reason for this is the extremely diverse set of players involved in the development, planning, deployment and operation of transportation infrastructure and services. Some ITS products will be developed and deployed wholly within the private sector, as consumer products. Other ITS deployment and operations will unfold through partnerships involving federal, state, and local governments, and the private sector. Others may be primarily public sector activities.

Where is ITS Today?

ITS should not be regarded as futuristic or even the technology of tomorrow. ITS is here and now. Traffic surveillance systems are increasingly visible on the roadway. Commercial vehicles and transit operators routinely use vehicle location systems and on-board computers to manage their fleets. Electronic toll collection systems are springing up around the country, and in-vehicle route guidance systems are available to consumers. Table 2 presents a "snapshot" of current deployment in the United States.

How Will ITS Be Deployed in the Future?

As shown above, there are a number of ITS services emerging in the market place. A number of others are "on-the-shelf" and could be deployed under the proper circumstances. ITS could evolve over the next 10 years in a number of possible ways. Future deployment of ITS can be characterized as a three-stage process:

1997-1999: The Era of Travel Information and Fleet Management
2000-2005: The Era of Transportation Management
2010: The Era of the Enhanced Vehicle.

Table 1- User Service Bundles

Bundle	User Services
1. Travel and Transportation Management	1. En-Route Driver Information 2. Route Guidance 3. Traveler Services Information 4. Traffic Control 5. Incident Management 6. Emissions Testing and Mitigation
2. Travel Demand Management	1. Demand Management and Operations 2. Pre-Trip Travel Information 3. Ride Matching and Reservation
3. Public Transportation Operations	1. Public Transportation Management 2. En-Route Transit Information 3. Personalized Public Transit 4. Public Travel Security
4. Electronic Payment	1. Electronic Payment Services
5. Commercial Vehicle Operations	1. Commercial Vehicle Electronic Clearance 2. Automated Roadside Safety Inspection 3. On-board Safety Monitoring 4. Commercial Vehicle Administrative Processes 5. Hazardous Materials Incident Response 6. Freight Mobility
6. Emergency Management	1. Emergency Notification and Personal Security 2. Emergency Vehicle Management
7. Advanced Vehicle Control and Safety Systems	1. Longitudinal Collision Avoidance 2. Lateral Collision Avoidance 3. Intersection Collision Avoidance 4. Vision Enhancement for Crash Avoidance 5. Safety Readiness 6. Pre-Crash Restraint Deployment 7. Automated Highway System

Table 2: A Snapshot of Current Deployment

Travel and Transportation Management

Many metropolitan and state transportation agencies employ some form of advanced transportation management system. Loop detectors, video cameras, and vehicle identification devices such as toll tags can be used to monitor current traffic conditions. Active control of traffic is achieved through use of signal timing, ramp meters, variable message signs, highway advisory radio, and commercial traffic information reporting services. Adaptive, real time traffic control systems are now available, but most signal timing adjustments are still made by time of day or other pre-established patterns.

Private sector companies collect travel information from a variety of sources; then package and sell the information. Radio and television broadcasts provide travelers with information that may allow them to make better travel choices. Personal devices (such as digital cellular telephone and paging systems, portable digital personal communications devices, in-vehicle subcarrier radio, and palm top computers) can be used to receive travel information; however, widespread implementation is hampered by uncertainty about marketability and a lack of specific, localized traveler information.

Static route guidance systems are commercially available to consumers as in-vehicle devices, in rental cars, and as personal computer software packages. Dynamic route guidance systems cannot be widely implemented until more real-time travel data is available and greater consistency can be achieved among jurisdictions.

Commercial Vehicle Operations

Commercial fleet management systems have been deployed in over half the major US trucking fleets. Private truck and bus companies incorporate safety data from on-board devices, such as engine temperature and driver hours, in their routing and dispatching decisions. Automatic vehicle and container identification systems are expediting just-in-time deliveries and intermodal shipping operations.

Motor Carrier Management Information System (MCMIS) is a federal database of motor carrier safety information used by states in roadside inspections. Automatic vehicle identification and weigh-in-motion technologies are used to gather information on truck credentials and vehicle weight. Heavy Vehicle Electronic License Plate, Inc. (HELP, Inc.) and the Advantage I-75 operational test will soon use electronic clearance services to permit safe and legal trucks equipped with transponders to bypass weigh stations and state ports-of-entry at highway speeds.

Some states are use pen-based data input devices to quickly upload inspection data electronically, reducing the total time for routine roadside safety inspections of trucks and buses. Vehicle inspections still are conducted manually. Advanced inspection procedures are under development.

Advanced Vehicle Control and Safety Systems

A few longitudinal and lateral collision warning systems are available on the market. All of the major automobile manufacturers are working on intelligent cruise control systems. These systems are expected to be available within 3 to 5 years, perhaps in conjunction with rear end collision avoidance systems to reduce liability risks.

Public Transportation Operations

Most large- and medium-sized transit agencies use scheduling and run-cutting software. Computer-aided dispatch transit radio systems and automatic vehicle location systems are becoming more commonplace among agencies. Fourteen transit properties currently have automated vehicle location capability. Location information is provided by GPS, signposts, or map matching applications.

Demand responsive trip scheduling software is in widespread use in specialized transportation systems for older and disabled travelers. Some small systems use route deviation schemes. Advanced transit security devices, such as closed circuit TV in parking lots and stations, slow-scan recording cameras in vehicles, and emergency alarms in vehicle radios, are in use.

Emergency Management

Nationwide, 24 emergency management systems are now equipped with automatic vehicle location (AVL) systems, 104 others are planning to implement AVL. Enhanced 9-1-1 deployment is bringing emergency services to accident scenes more quickly and efficiently. Through automatic phone number and location identification, emergency service vehicles are assigned to respond and are quickly routed to the proper location.

Electronic Payment

Several public transit systems now use magnetic stripe technology to collect fares. Some systems are evaluating the use of "smart cards" for multiple transportation and non-transportation purposes, such as parking fees and telephone usage. Electronic payment systems are planned or deployed at 20 toll facilities around the country, and a robust, competitive market has developed for these systems. In some regions efforts are underway to install compatible systems in adjacent states, but broad interoperability has not yet been achieved. Standards development to address interoperability is making headway, however.

Table 3 provides descriptions of the systems that may be deployed in each of these eras. The final form of ITS deployment will be influenced by a confluence of factors and the cumulative impact of decisions made by a number of diverse players. Private sector activities in ITS depend heavily on their confidence in the market for ITS and their ability to develop a revenue stream. Because state and local governments are directly responsible for construction, operation, and maintenance of the transportation systems in their jurisdictions, they have a major role in how ITS deployment will take shape. The US DOT has an important role in supporting the deployment of ITS through research, development, testing, and support for early deployment planning.

IV. SUPPORTING ITS DEPLOYMENT

ITS deployment is under way. The NPP identifies a number of broad challenges that will sustain and in some cases, accelerate the development and deployment of ITS. These include the problems of national compatibility and a series of near- and long-term institutional challenges.

National Interoperability

National compatibility and interoperability is not likely to emerge from a random, evolutionary process. It must be fostered through cooperation. The development of the National ITS Architecture and on-going work in the development of standards are essential components of this effort.

The National ITS Architecture will provide a framework that describes how ITS components interact and work together to achieve total system goals. Many different designs might be implemented within the framework of an architecture. An open system architecture will describe the system operation and the information exchanged among the components. The architecture will also be modular, which will facilitate the introduction of new technologies and system capabilities. Phase I, completed in January 1995, produced four architectures. Two teams, led by Loral Federal Systems and Rockwell were selected to implement Phase II. They are working together in a non-competitive environment to refine the Phase I architectures into a single national ITS architecture. This phase began in February 1995 and is scheduled for completion in July 1996. Each step in the process has included a broad consensus effort as an intregal part of the architecture development.

Establishment of ITS standards will also accelerate ITS development and deployment in several ways. Appropriate standards will facilitate national, global, and cross-modal compatibility and interoperability and help U.S. industries gain greater access to the international ITS marketplace by ensuring that ITS components will operate in a consistent, predictable way. Standards development will improve overall product design and performance, safety, and ease of operation and maintenance. The emergence of industry

Table 3: Future Deployment Scenarios

1997-1999: THE ERA OF TRAVEL INFORMATION AND FLEET MANAGEMENT

Private companies and public agencies at all levels, and for all modes collect travel data; however, no one has a broad enough information network to support real-time, detailed travel decision making. A crucial ITS objective in the next three to five years is to build the relationships among public agencies and private companies necessary to share data from all modes of surface transportation and provide that data to the public in a timely and effective way. The development of rich, shared travel information bases could provide the foundation on which states and metropolitan areas could support and integrate many ITS traffic, transit, safety, and commercial vehicle services. Over time, data bases will be expanded to provide more detailed and comprehensive transportation information.

Data sharing for commercial vehicle operations will accelerate as well. State databases, linked to exchange regulatory and safety information, will boost the use of advanced technologies to verify credentials and monitor fleet safety performance. Automated vehicle identification and weigh-in-motion systems will be operational on most major trucking corridors and international border crossings. Navigation systems using GPS and satellite communications will become common in truck and bus fleets, enhancing the efficiency of freight distribution and fleet management systems.

Electronic toll collection systems will be deployed at an accelerated pace as their convenience is recognized by the general public and toll authorities begin to achieve cost savings.

By reaching this interim ITS deployment scenario, the stage will be set for achieving longer term transportation management objectives and establishing U.S. industries as strong players in the global market for ITS technologies and services. The completion of the national ITS architecture and the emergence of more public infrastructure will provide private sector companies with greater confidence about entering the ITS market and supporting the communications required by transportation management systems.

The technologies will be available to implement congestion pricing if local policy dictates. Revenues from congestion pricing applications and privatization activities might be seen as an appropriate resource for ITS operations and maintenance funding.

Automobile manufacturers will offer a variety of in-vehicle products, such as intelligent cruise control. Autonomous route guidance systems will be readily available to consumers, and as travel information bases mature, dynamic route guidance will become possible in some parts of the country. Mayday safety and security services will be deployed in both rural and urban areas.

2000-2005: THE ERA OF TRANSPORTATION MANAGEMENT

By the turn of the century the vision of the "smart traveler" can indeed become a reality. With the institutional mechanisms and transportation infrastructure in place to provide a steady stream of reliable travel information, effective personal and public transportation management can take place. State and local agencies will have established the alliances with the private sector for the travel information dissemination methods that work best in their own areas. More capable roadside-to-vehicle communications infrastructure will be deployed to provide richer data and real-time, adaptive traffic control over large areas will become a realistic goal.

Jurisdictions will cooperate to support real-time sharing of information and transportation management strategies by traffic, freeway, transit, and emergency services control centers. Integration and adaptive control of freeways and surface streets will improve the flow of traffic, give preference to public safety, transit, and other high occupancy vehicles, and minimize congestion. The public and private sectors will cooperate to share the up-to-the-minute information needed to support real-time, dynamic route guidance systems for private and commercial vehicles.

Universal electronic payment systems will be available for tolls, transit fares, parking, and other financial transactions. Communities wishing to implement congestion pricing strategies will have a ready infrastructure and may see this as a source for operations and maintenance support.

By the year 2000, electronic clearance for commercial vehicles may be operational nationwide. An integrated network and database of electronic clearance and safety information will be available to support North American uniformity and productivity for the nation's commercial fleets. Hazardous materials incident notification services will provide early, accurate information for emergency responders in some segments of the motor carrier industry.

In this second wave of deployment, application of aerospace and defense technologies will provide dramatic advances to automotive systems to improve traveler safety and provide real-time navigation assistance. Enhanced vehicle control systems, such as lateral warning and early collision avoidance features, will be marketed in private vehicles. Deployment of vehicle-to-vehicle communications systems may make preliminary intersection collision avoidance systems possible.

2010: THE ERA OF THE ENHANCED VEHICLE

By the year 2010, research and testing will have brought ITS to a stage of reliability and accuracy that will support introduction of more sophisticated vehicle safety and control services, such as in-vehicle signing and more advanced collision avoidance systems. These advanced systems will include lateral and longitudinal space control, vision enhancement systems, and assisted braking and steering. The data collection, sharing, and dissemination systems established in preceding years will provide a foundation for the early stages of deployment of automated highway systems.

standards will also boost consumer confidence, because new ITS products would be more likely to retain their value. Costs for manufacturers could be reduced by mitigating the risk that new products would depend upon "orphan" technologies. Although standard setting activities are underway, the adoption of the National ITS Architecture in 1996 will provide the framework for establishing many new ITS standards.

Near-term Institutional Challenges

The NPP identifies a number of important challenges which must be addressed and, if possible, resolved. The challenges which impact those ITS services already in the deployment phase and those which could be deployed in a three to five year time frame, are described below.

- *Lack of Market Information* - Before committing resources to marketing and deploying ITS services, many stakeholders feel they need a better understanding of the potential market for ITS. Public agencies want to know if ITS will influence traveler behavior and whether ITS might help generate revenue. Private companies need to determine the market risk involved in ITS investments and how soon investments can be recouped.

- *Uncertain public infrastructure base* - Although most ITS stakeholders believe a public ITS infrastructure will eventually be in place, they are uncertain about its nature and extent. Private companies do not want to rush to build private infrastructure, such as transportation data collection infrastructure, if public platforms will soon emerge. They also want greater assurance that their products and services will be compatible with the technologies that will ultimately dominate the public infrastructure.

- *Competition for scarce resources* - Current demands for transportation funding outstrip resources at all levels of government. Public ITS deployment investments compete with traditional projects such as highway resurfacing and reconstruction, transit fleet replacement, and other types of important capital improvements. Proposed ITS deployments must demonstrate that they will deliver significant travel efficiencies and other public benefits to win funding commitments for initial deployment as well as continuing operation and maintenance expenses.

- *Need for new skills* - Public agencies may not have the technical and engineering skills that are needed to manage the application of electronics and communications technologies to transportation services. Agencies must seek employees with appropriate technical training, provide updated training for current personnel, or use private sector technical expertise to substitute for or augment public agency skills.

- *Inexperience in partnerships* - ITS will cross city, state, and even international boundaries, and will link services which have traditionally been delivered by separate public agencies. Successful ITS deployment will depend upon the formation of new partnerships among different levels of government, across geographical lines, and even among agencies within jurisdictions. Possibly the most significant partnerships to be established in the near term are those between the public and private sectors to distribute